**NATURAL RESOURCES CONSERVATION SERVICE**
**CONSERVATION PRACTICE STANDARD**
***SOUTH DAKOTA SUPPLEMENTS ITALICIZED***

# POND

**(*no*.)**
**CODE 378**

## DEFINITION

A water impoundment made by constructing a dam or an embankment or by excavating a pit or dugout.

In this standard, ponds constructed by the first method are referred to as embankment ponds, and those constructed by the second method are referred to as excavated ponds. Ponds constructed by both the excavation and the embankment methods are classified as embankment ponds if the depth of water impounded against the embankment at spillway elevation is 3 feet or more.

## PURPOSE

To provide water for livestock, fish and wildlife, recreation, fire control, crop and orchard spraying, and other related uses, and to maintain or improve water quality.

## SCOPE

This standard establishes the minimum acceptable quality for the design and construction of ponds if:

Failure of the dam will not result in loss of life; in damage to homes, commercial or industrial buildings, main highways, or railroads; or in interruption of the use or service of public utilities.

The product of the storage *volume multiplied by* the effective height of the dam is less than 3,000. Storage is the volume, in acre-feet, in the reservoir below the elevation of the crest of the emergency spillway. The effective height of the dam is the difference in elevation, in feet, between the emergency spillway crest and the lowest point in the cross section taken along the centerline of the dam. If there is no emergency spillway, the top of the dam is the upper limit.

The effective height of the dam is 35 feet or less, and the dam is hazard class (a).

## CONDITIONS WHERE PRACTICE APPLIES

**Site conditions.** Site conditions shall be such that runoff from the design storm can be safely passed through (1) a natural or constructed emergency spillway, (2) a combination of a principal spillway and an emergency spillway, or (3) a principal spillway.

**Drainage area.** The drainage area above the pond must be protected against erosion to the extent that expected sedimentation will not shorten the planned effective life of the structure. The drainage area shall be large enough so that *50 percent chance annual yield exceeds the permanent water storage volume of the reservoir*. The quality shall be suitable for the water's intended use.

**Reservoir area.** The topography and soils of the site shall permit storage of water at a depth and volume that ensure a dependable supply, considering beneficial use, sedimentation, season of use, and evaporation and seepage losses. If surface runoff is the primary source of water for a pond, the soils shall be impervious enough to prevent excessive seepage losses or shall be of a type that sealing is practicable.

## CONSIDERATIONS

**Water Quantity**

Effects upon components of the water budget, especially effects on volumes and rates of runoff, infiltration, evaporation, transpiration, deep percolation, and ground water recharge.

Variability of effects caused by seasonal or climatic changes.

Effects on the downstream flows or aquifers that could affect other water uses or users.

Potential for multiple use.

Effects on the volume of downstream flow to prohibit undesirable environmental, social or economic effects.

**Water Quality**

Effects on erosion and the movement of sediment, pathogens, and soluble and sediment attached substances that are carried by runoff.

Effects on the visual quality of onsite and downstream water resources.

Short-term and construction-related effects of this practice on the quality of downstream water courses.

Effects of water level control on the temperatures of downstream water to prevent undesired effects on aquatic and wildlife communities.

Effects on wetlands and water-related wildlife habitats.

Effects of water levels on soil nutrient processes such as plant nitrogen use or denitrification.

Effects of soil water level control on the salinity of soils, soil water, or downstream water.

Potential for earth moving to uncover or redistribute toxic materials such as saline soils.

## *CRITERIA FOR ALL PONDS*

***Laws and Regulations.*** *This practice must conform to all federal, state, and local laws and regulations. Laws and regulations of particular concern include those involving water rights, land use,land disturbance by construction, pollution control, property easements, wetlands, preservation of cultural resources, and endangered species.*

***Sediment Control.*** *The drainage area above the pond must be protected from erosion to the extent needed to prevent sedimentation from reducing the designed life and purpose of the structure.*

***Fencing.*** *Fencing should be encouraged for all sites and required on sites where vegetation is expected to be difficult to establish and/or maintain. Fencing off all or portions of the reservoir should also be encouraged. This practice has many benefits to fish and wildlife, enhances water quality, and will extend the useful life of the structure.*

***Vegetation.*** *Where needed, disturbed areas should be topsoiled to aid vegetation establishment. All disturbed areas must be vegetated to control erosion and noxious weeds.*

***Drawdown.*** *It is highly desirable that ponds have a pipe and gate or valve assembly, which will allow draining the impounded water from the reservoir for management purposes.*

**Visual resource design.** The visual design of ponds shall be carefully considered in areas of high public visibility and those associated with recreation. The underlying criterion for all visual design is appropriateness. The shape and form of ponds, excavated material, and plantings are to relate visually to their surroundings and to their function.

The embankment may be shaped to blend with the natural topography. The edge of the pond may be shaped so that it is generally curvilinear rather than rectangular. Excavated material can be shaped so that the final form is smooth, flowing, and fitting to the adjacent landscape rather than angular geometric mounds. If feasible, islands may be added for visual interest and to attract wildlife.

## CRITERIA FOR EMBANKMENT PONDS

***Foundation Investigation.*** *Soil borings will be made for each dam for design purposes as needed. Whenever questionable materials are encountered, soil samples will be sent to a laboratory for analysis.*

***Foundation Stripping.*** *Foundations must be stripped to a minimum depth of 0.5 foot or to the depth of significant root development whichever is greater, to remove undesirable vegetation and roots which may exist. The stripped area must be scarified.*

**Foundation cutoff.** A cutoff of relatively impervious material shall be provided under the dam. *Minimum depth of cutoff is two feet.* The cutoff shall be located at or upstream from the centerline of the dam. It shall extend up the abutments as required and be deep enough to extend into a relatively impervious layer or provide for a stable dam when combined with seepage control. The cutoff trench shall have a bottom width adequate to accommodate the equipment used for excavation, backfill, and compaction operations. Side slopes shall not be steeper than one horizontal to one vertical. *For trenches over four feet deep, slopes 1.5 horizontal to 1 vertical or flatter may be required by the Occupational Safety and Health Administration (OSHA).*

**Seepage control.** Seepage control is to be included if (1) pervious layers are not intercepted by the cutoff, (2) seepage creates swamping downstream, (3) such control is needed to insure a stable

embankment, or (4) special problems require drainage for a stable dam. Seepage may be controlled by (1) foundation, abutment, or embankment drains; (2) reservoir blanketing; or (3) a combination of these measures.

**Earth embankment.** The minimum top width for a dam is shown in Table 1. If the embankment top is to be used as a public road, the minimum width shall be 16 feet for one-way traffic and 26 feet for two-way traffic. Guardrails or other safety measures shall be used where necessary and shall meet the requirements of the responsible road authority.

***TABLE 1. MINIMUM TOP WIDTH FOR DAMS***

| Total height of embankment | Top width |
|---|---|
| ***Ft.*** | ***Ft.*** |
| *0 -99* | 6 |
| *10 - 14.9* | 8 |
| *15 - 19.9* | 10 |
| *20.0 - 24.9* | 12 |
| *25 - 34.9* | 14 |
| 35 or more | 15 |

*Upstream slopes of the settled embankment shall not be steeper than 3:1 (three horizontal to one vertical). Downstream side slopes shall not be steeper than 2:1 (two horizontal to one vertical).*

All slopes must be designed to be stable, even if flatter side slopes are required.

If needed to protect the slopes of the dam *from erosion*, special measures, such as berms, rock riprap, sand-gravel, soil cement, or special vegetation, shall be provided (Technical Releases 56 and 69).

The minimum elevation of the top of the settled embankment shall be 1 foot above the water surface in the reservoir with the emergency spillway flowing at design depth. The minimum difference in elevation between the crest of the emergency spillway and the settled top of the dam shall be 2 feet for all dams having more than a 20-acre drainage area or more than 20 feet in effective height.

*For dams without an emergency spillway, the settled embankment top must be at least 1.5 feet above the routed design hydrograph.*

The design height of the dam shall be increased by the amount needed to insure that after settlement the height of the dam equals or exceeds the design height. This increase shall not be less than five percent, except where detailed soil testing and laboratory analyses show that a lesser amount is adequate.

***Borrow Area.*** *The borrow area shall be stripped to remove all vegetation and material undesirable for fill. This stripped material may later be used as a covering over the dam and spillway area or to recover the borrow area so vegetation may be more easily reestablished.*

***Borrow Material.*** *Soils having total soluble salts exceeding 2.0 percent, or dispersion over 25 percent must not be used as borrow material except in special designs prepared by an engineer.*

**Principal Spillway *Need*.** Except where rock, concrete, or other types of mechanical spillways are used, a pipe conduit, with needed appurtenances, shall be placed under or through the dam *when any of the following conditions are present:*

*The soil of the excavated or natural spillway has high erodibility and will not support adequate vegetation;*

*The volume of water storage, less sediment design storage, in the dam at the emergency spillway crest elevation is less than 50 percent of the 2-year frequency, 24-hour storm yield;*

*The volume of water storage at the emergency spillway crest elevation exceeds 100 acre feet;*

*The product of storage times effective height exceeds 2,000;*

*Water from wells, springs, or seeps flow into the reservoir.*

***Principal Spillway Capacity.*** *For ponds with a product of storage times effective height exceeding 2,000, a 10-year frequency, 24-hour duration runoff must be contained between the crests of the principal spillway and emergency spillway when flood routed. The principal spillway must have capacity to empty this flood pool within 10 days.*

*When water from springs or other significant inflows enter the pond, the principal spillway capacity will be determined by routing the design storm from the crest of the principal spillway. When storm runoff is the only source of inflow, the minimum capacity of the principal spillway may be computed by the following formula:*

*(PSQ) = (A) (C) (QIN)*
*PSQ = minimum required principal spillway capacity in cubic feet per second (cfs).*
*A= adjustment factor for emergency spillway <u>exit</u> channel condition. (See Table below.)*

*C= adjustment factor for pond storage compared to runoff volume expected.*
*QIN= peak inflow in CFS from the drainage area above the pond. C and QIN are computed as follows:*

*Use the design storm in the following table to compute QIN and total volume of runoff (VR).*

| ***DRAINAGE AREA (AC)*** | ***DESIGN STORM FREQUENCY DURATION*** | ***PREFERRED VR, QIN COMPUTER METHOD*** |
|---|---|---|
| *to 1500* | *2-year, 24-hour* | *EFM2 or IOWA POND* |
| *1500 to 2500* | *5-year, 24-hour* | *EFM2 or TR55* |
| *2501 +* | *10-year, 24-hour* | *TR55 OR SITES* |

*Next, compute pond storage to crest of emergency spillway minus sediment storage (VP) in acre feet. Compute VP/VR and find C in the following table:*

| *VP / VR* | *.00* | *.01* | *.02* | *.03* | *.04* | *.05* | *.06* | *.07* | *.08* | *.09* |
|---|---|---|---|---|---|---|---|---|---|---|
| | ***C*** | | | | | | | | | |
| *.0* | *1.00* | *.92* | *.88* | *.86* | *.83* | *.81* | *.80* | *.78* | *.76* | *.75* |
| *.1* | *.74* | *.72* | *.71* | *.70* | *.69* | *.68* | *.67* | *.66* | *.65* | *.64* |
| *.2* | *.63* | *.62* | *.61* | *.60* | *.59* | *.58* | *.57* | *.57* | *.56* | *.55* |
| *.3* | *.54* | *.53* | *.53* | *.52* | *.51* | *.51* | *.50* | *.49* | *.48* | *.48* |
| *.4* | *.47* | *.46* | *.46* | *.45* | *.45* | *.44* | *.43* | *.43* | *.42* | *.41* |
| *.5* | *.41* | *.40* | *.40* | *.39* | *.39* | *.38* | *.37* | *.37* | *.36* | *.36* |
| *.6* | *.35* | *.35* | *.34* | *.34* | *.33* | *.33* | *.32* | *.32* | *.31* | *.31* |
| *.7* | *.30* | *.30* | *.29* | *.29* | *.28* | *.28* | *.27* | *.27* | *.26* | *.26* |
| *.8* | *.25* | *.25* | *.24* | *.24* | *.23* | *.23* | *.22* | *.22* | *.22* | *.21* |
| *.9* | *.21* | *.20* | *.20* | *.19* | *.19* | *.18* | *.18* | *.18* | *.17* | *.17* |

*In the above table, C equals one minus the square root of (0.7) VP/VR.*

| ***General Condition of Emergency Spillway Exit Channel After Construction*** | ***A*** |
|---|---|
| *Dense sod, good spread, no overfalls* | *0.20* |
| *Sod or shrubs, small overfalls* | *0.35* |
| *Poor vegetation, overfalls* | *0.50* |
| *Very poor vegetation, large overfalls, erosive soils* | *0.70* |

***Principal Spillway Details.*** *The crest or invert elevation of the principal spillway pipe shall be set at an elevation below the crest of the emergency spillway which will assure full pipe flow at design capacity, before flow occurs in the emergency spillway.*

Inlets and outlets shall be designed to function satisfactorily for the full range of flow and hydraulic head anticipated.

*Minimum principal spillway pipe diameter is 8 inches. Minimum drop inlet riser diameter is 1.25 times the horizontal pipe diameter. The riser and barrel for dropinlet spillways shall be designed to provide full pipe flow after weir flow is exceeded. The maximum depth of drop inlet risers shall not exceed 12 feet in semi-compacted fill except where the riser is designed to withstand fill settlement (vertical compression) loading.*

*Requirements of Tables 2 and 3 are to be followed for smooth polyvinyl chloride (PVC), corrugated polyethylene (PE), corrugated steel, and corrugated aluminum pipes.*

***Pipes Buried Less Than 15 Feet.*** *For all pipes buried less than 15 feet in pond dams, the following requirements must be met. All pipes must be water tight (including joints) and must be capable of withstanding all internal and external loads without bursting, yielding, buckling, moving, or cracking. Flexible pipe strength shall not be less than that necessary to support the design load with a maximum of 7.5 percent deflection.*

The inlets and outlets shall be structurally sound and made of materials compatible with those of the pipe.

*Acceptable* pipe materials are *plastic,* cast-iron, steel, corrugated steel or aluminum, *reinforced* concrete, and cast-in-place reinforced concrete. Plastic pipe that will be exposed to direct sunlight shall be made of ultraviolet-resistant materials and protected by coating or shielding, or provisions for replacement should be made as necessary. Connections of plastic pipe to less flexible pipe or structures must be designed to avoid stress concentrations that could rupture the plastic.

***Pipes Buried 15 Feet or More.*** *For all pipes buried 15 feet or more, the following requirements must be met. All pipes must be water tight (including joints) and must be capable of withstanding all internal and external loads without bursting, yielding, buckling, moving, or cracking. Flexible pipe strength shall not be less than that necessary to support the design load with a maximum of five percent deflection. Pipes* shall be plastic, reinforced concrete, cast-in-place reinforced concrete, *cast iron,* corrugated *iron,* steel or aluminum, or welded steel pipe. The maximum height of fill over any principal spillway steel or aluminum pipe must not exceed 25 feet. Pipes shall be watertight. The joints between sections of pipe shall be designed to remain watertight after joint elongation caused by foundation consolidation. Concrete pipe shall have concrete bedding or a concrete cradle, if required. Cantilever outlet sections, if used, shall be designed to withstand the cantilever load. Pipe supports shall be provided when needed. Other suitable devices such as a Saint Anthony Falls *(SAF)* stilling basin or an impact basin may be used to provide a safe outlet. Protective coatings of *aluminum on corrugated iron or steel pipe or* vinyl on galvanized corrugated *iron or steel* pipe, or coal tar enamel on welded steel pipe should be provided in areas that have a history of pipe corrosion, or where the saturated soil resistivity is less than 4,000 ohms-cm, or where soil pH is lower than 5.

Cathodic protection is to be provided for coated welded steel and galvanized corrugated metal pipe where soil and resistivity studies indicate that the pipe needs a protective coating, and where the need and importance of the structure warrant additional protection and longevity.

*Table 2.- Acceptable Plastic Pipe For Use In Dams*

| Applicable Standard | Diameter Limit (inch) | Maximum Depth Fill Over Pipe (feet) |
|---|---|---|
| Acceptable Polyvinyl Chloride (PVC 1120 and 1220) Pipe: | | |
| ASTM D2241, SDR 41 | | 8 |
| AWWA C900, DR 41 | | 8 |
| ASTM D3034, SDR 35 (Sewer) | | 11 |
| ASTM D2241, SDR 32.5 | | 12 |
| ASTM D1785, Schedule 40 | 10 to 12 | 12 |
| ASTM D1785, Schedule 40 | 8 | 18 |
| ASTM D2241, SDR 26 | | 18 |
| AWWA C900, DR 25 | | 18 |
| AWWA C900, DR 14 and DR 18 | | 30 |
| ASTM D1785, Schedule 80 | 8 to 12 | 30 |
| Acceptable Polyethylene (PE) Double Wall Corrugated Smooth Interior Pipe: | | |
| AASHTO M294-97 | | |
| ASTM D3350 | 8 to 18 | 10 |
| | >18 | 7 |

**Table 3 - Minimum Gage For Corrugated Metal Pipe [2-2/3-in x ½-in Corrugations][1]**

| Fill height (ft) | Minimum gauge for steel pipe with diameter (in) of | | | | | |
|---|---|---|---|---|---|---|
| | 21 and less | 24 | 30 | 36 | 42 | 48 |
| 1 - 15 | 16 | 16 | 16 | 14 | *14* | *12* |
| 15 - 20 | 16 | 16 | 16 | 14 | 12 | *12* |
| 20 - 25 | 16 | 16 | 14 | 12 | *12* | *12* |

| Fill height (ft.) | Minimum thickness (in) of aluminum pipe[2] with diameter (in) of | | | |
|---|---|---|---|---|
| | 21 and less | 24 | 30 | 36 |
| 1 - 15 | 0.06 | 0.06 | 0.075 | 0.075 |
| 15 - 20 | 0.06 | 0.075 | 0.105 | 0.105 |
| 20 - 25 | 0.06 | 0.105 | 0.105 | ----[3] |

1/ Pipe with 6-, 8-, and 10-inch diameters has 1-1/2 inch x ¼- inch corrugations.
2 Riveted or helical fabrication.
3/ Not permitted

***Pipe Outlet.*** *Where a SAF stilling basin, impact basin, or flared outlet is not used, the principal spillway outlet must be placed between 1.0 and 3.0 feet above the base grade of the outlet channel. When pipe supports are used, the outlet end of the pipe must extend at least five feet beyond the point where the downstream slope of the dam fill intersects the flow line of the outlet channel or waterway. When pipe supports are not used, the pipe outlet must extend at least five feet from the intersection of the fill and bottom of pipe.*

*The pipe outlet must be held firmly in position by pipe supports, earth or rock fill, or other means. Pipe supports shall be provided when the pipe diameter exceeds 21 inches, and as needed on smaller diameter pipe when site conditions dictate (long duration flows, eroding conditions, etc.)*

*For pipe outlets larger than 15 inches in diameter, the outlet pipe slope must not exceed 5 percent except where the design is approved by an engineer.*

***Seepage Control.*** *For dams with permanent water storage, seepage along pipes passing through or under dams must be controlled by an antiseep collar or filter drain.*

*If a filter drain is used, it* is to consist of sand, meeting fine concrete aggregate requirements (at least 15 percent passing the No. 40 sieve but no more than 10 percent passing the No. 100 sieve). If unusual soil conditions exist, a special design analysis shall be made.

The drain shall be a minimum of two feet thick and extend vertically upward two *feet* and horizontally *from the pipe at least two feet or two pipe diameters, whichever is larger. It shall extend* vertically downward at least 18 inches beneath the conduit invert. The drain diaphragm shall be located *downstream of the cutoff trench.*.

The drain shall be outletted at the embankment downstream toe, using a drain backfill envelope continuously along the pipe to where it exits the embankment *or by using a drain pipe. Exposed drain fill must be protected from erosion.*

When antiseep collars are used in lieu of a drainage diaphragm, they shall have a watertight connection to the pipe. Maximum spacing shall be approximately 14 times the minimum projection of the collar measured perpendicular to the pipe. *Locate antiseep collars near or upstream of the centerline of the dam.* Collar material shall be compatible with pipe materials. The antiseep collar(s) shall increase by 15 percent the seepage path along the pipe.

***Trash Rack and Anti Vortex Device.*** Closed conduit spillways designed for pressure flow must have adequate antivortex devices.

*A trash rack or safety guard shall be installed over all drop inlets.*

***Drawdown Pipe.*** A pipe with a suitable valve shall be provided to drain the pool area if needed for proper pond management or if required by state law. The principal spillway conduit may be used as a pond drain if it is located where it can perform this function.

Supply pipes through the dam to watering troughs and other appurtenances shall have an inside diameter of not less than 1-1/4 inch *and shall be designed for 160 psi minimum working pressure.*

*To retard seepage, at least one antiseep collar (two foot by two foot or larger) must be located on the pipe upstream of the centerline of the dam.*

**Emergency spillways.** Emergency spillways convey large flood flows safely past earth embankments.

An emergency spillway must be provided for each dam, unless the principal spillway is large enough to pass the peak discharge from the routed design hydrograph and the trash that comes to it without overtopping the dam. The following are minimum criteria for acceptable use of a closed conduit principal spillway without an emergency spillway: a conduit with a cross-sectional area of three feet$^2$ or more, an inlet that will not clog, and an elbow designed to facilitate the passage of trash.

The minimum capacity of a natural or constructed emergency spillway shall be that required to pass the peak flow expected from a design storm of the frequency and duration shown in Table 4, less any reduction creditable to conduit discharge and detention storage.

The emergency spillway shall safely pass the peak flow, or the storm runoff shall be routed through the reservoir. The routing shall start either with the water surface at the elevation of the crest of the principal spillway or at the water surface after 10 days' drawdown, whichever is higher. The 10-day drawdown shall be computed from the crest of the emergency spillway or from the elevation that would be attained if the entire design storm were impounded, whichever is lower. Emergency spillways shall provide for *safely* passing the design flow to a point downstream where the dam will not be endangered.

Constructed emergency spillways are open channels that usually consist of an inlet channel, a control section, and an exit channel. They shall be trapezoidal and shall be located in undisturbed or

compacted earth. The side slopes shall be stable for the material in which the spillway is to be constructed, *but not steeper than 2:1 in earth materials*. For dams having an effective height exceeding 20 feet, the emergency spillway shall have a bottom width of not less than *2*0 feet.

Upstream from the control section, the inlet channel shall be level for the distance needed to protect and maintain the crest elevation of the spillway (*at least 20 feet)*. The inlet channel may be curved to fit existing topography. *In erodable materials, the maximum flow depth used in computing spillway discharge shall be 2.5 feet with depths of 2 feet or less recommended.*

**Table 4.-Minimum Spillway Capacity**

| Drainage area | Effective height of dam[1] | Storage | Minimum design storm[2] | |
|---|---|---|---|---|
| | | | Frequency | Minimum duration |
| *Ac.* | *Ft.* | *Ac.-Ft.* | *Yr.* | *Hr.* |
| 20 or less | 20 or less | < than 50 | 10 | 24 |
| All others | All others | < than 50 | 25 | 24 |
| All others | | > than 50 | 50 | 24 |

1/ As defined under "Scope."
2/ Select rain distribution based on climatological region.

*Where possible, the outlet channel should be straight. Outflows must be directed away from the dam. If outflow dikes are used, side slopes must be 2:1 or flatter and top width at least four feet.*

*Natural formed spillways with grass cover may be used if they are adequate in size, shape, and direct spillway flows away from the embankment.*

*The maximum permissible velocity in the spillway control section shall not exceed maximum permissible velocities for the soil type or planned grass cover (see Tables 5 and 6.). In excavated spillways there shall be a minimum cut of 1.0 foot in the control section adjacent to the dam fill.*

***TABLE 5. PERMISSIBLE VELOCITIES FOR VEGETATED EARTH SPILLWAYS 1/***

| *Spillway Vegetation and Slope of Exit Channel* | *Maximum Permissible Velocities - ft./sec.* | |
|---|---|---|
| | *Easily Eroded Soils* | *Moderate to High Erosion Resistant Soils* |
| *Poor vegetation 1/* | | |
| *Slopes 0-5%* | *3.0* | *4.0* |
| *Good vegetation* | | |
| *Slopes 0-5%* | *5.0* | *7.0* |
| *Slopes over 5%* | *4.0* | *5.5* |

1/ *Top dressing the emergency spillway with topsoil and seeding with erosion resistant grasses improves vegetative conditions and allows for an increase in permissible velocities. (See Critical Area Planting - 342 for appropriate seed mixture.)*

***TABLE 6. PERMISSIBLE VELOCITIES FOR EARTH SPILLWAYS. (NON-VEGETATED)***

| *Erodibility* | *Unified Soil Classification System* | *Maximum Permissible Velocity ft./sec.* |
|---|---|---|
| *High* | *ML, SP, SM, SW SC, MH, CL, CH, Fine GP* | *2.0* |
| *Moderate* | *Fine GW, Fine GC Coarse GP, Coarse GW* | *3.5* |
| *Low* | *Coarse GC* | *5.0* |

**Structural Emergency Spillways.** If chutes or drops are used for principal spillways or emergency spillways, they shall be designed according to the principles set forth in the Engineering Field Manual for Conservation Practices and the National Engineering Handbook-Section 5, Hydraulics; Section 11, Drop Spillways; and Section 14, Chute Spillways. The minimum capacity of a structural spillway shall be that required to pass the peak flow expected from a design storm of the frequency and duration shown in Table 4, less any reduction creditable to conduit discharge and detention storage.

***Wave Protection.*** *Provisions must be made to counter the effect of wave action whenever the surface area of the reservoir exceeds five acres or when erosion of the upstream slope is expected due to orientation of the reservoir. One of the following methods may be used for control of wave action:*

***Method No. 1****. A 10:1 or flatter berm having a minimum width of 10 feet shall be constructed on the upstream face of the embankment at normal pool level. Sandbar willow may be planted on this berm.*

*The upstream slope of the dam shall have a slope above the berm will not be steeper than 3:1.*

***Method No. 2****. Rock riprap will be placed on the upstream face of the dam from a point at least two feet above the elevation of the normal water line to a point two feet below the lowest anticipated water level in the pond.*

***Method No. 3****. The upstream slope of the dam will have a slope of 6:1 or flatter from a point at least two feet above the elevation of the normal water line to a point two feet below the lowest anticipated water level. Well-graded gravel, approximately one foot in thickness, placed on the flattened slope may be used to increase the protection against wave erosion.*

***Method No. 4****. Other designs approved by an engineer may be used.*

## CRITERIA FOR EXCAVATED PONDS

**Runoff.** Provisions shall be made for a pipe and emergency spillway if necessary. Runoff flow patterns shall be considered when locating the pit and placing the spoil (see Table 4).

**Side slopes.** Side slopes of excavated ponds shall be stable and shall not be steeper than *1.5* horizontal to one vertical. If livestock will water directly from the pond, a watering ramp of ample width shall be provided. The ramp shall extend to the anticipated low water elevation at a slope no steeper than *four* horizontal to one vertical.

**Perimeter form.** If the structures are to be used for recreation or are highly visible to the public, the perimeter or edge should be curvilinear.

**Inlet protection.** If surface water enters the pond in a natural or excavated channel *consideration should be given to protecting* the side slope of the pond against erosion.

**Excavated material.** The material excavated from the pond shall be placed so that its weight will not endanger the stability of the pond side slopes and so that it will not be washed back into the pond by rainfall. *Spoil must not be placed in a manner that will cause erosion, restrict runoff flow or limit floodplain capacity.* It shall be disposed of in one of the following ways:

Uniformly spread to a height that does not exceed three feet, with the top graded to a continuous slope away from the pond.

Uniformly placed or shaped reasonably well, with side slopes assuming a natural angle of repose. The excavated material will be placed at a distance equal to the depth of the pond but not less than 12 feet from the edge of the pond.

Shaped to a designed form that blends visually with the landscape.

Used for low embankment and leveling.

Hauled away.

## *CRITERIA FOR LIVESTOCK WATER*

*The reservoir water storage on ponds designed for livestock should not exceed the volume of runoff produced from a 50 percent chance annual yield from the drainage area.*

*The minimum depth of water on ponds designed for livestock shall be 10 feet east and 12 feet west of the Missouri River. If ground water is encountered, the minimum depth may be less for excavated ponds but must be at least 1.0 feet below the average <u>low</u> ground water level. In no case shall the effective depth be less than six feet. Embankment ponds must have a minimum 500 square foot bottom area at the minimum allowable depths. Excavated ponds must have a minimum 500 square foot of bottom area at the design depth.*

*This practice must (1) facilitate proper grazing use by improving distribution of grazing, (2) meet the water requirements of livestock with acceptable quality water, and (3) be the most feasible method of development for the needed water supply.*

*Distribution of stock watering places should be such that livestock need not travel more than one mile between forage and dependable water on gentle relief. On rough relief, the greatest travel distance form forage to water should not exceed one-half mile.*

## *CRITERIA FOR FISHPONDS*

*This criteria applies to planned portions of ponds for the standard for Fishpond Management (399).*

*The drainage area must not include areas of concentrated organic wastes or other sources of pollution. Reservoir water storage to the top of the fishpond water volume must not exceed the volume of runoff produced from a 50 percent annual yield from the drainage area.*

*Exclude livestock from shoreline areas except for limited lanes for livestock water. Provide a buffer of perennial vegetation at least 50 feet wide between the pond and cropland or barren areas.*

*The source of water shall be adequate to maintain required water depths, water quality, and water temperatures for the fish species identified on form SD-CPA-26.*

***Trout Pond.*** *For constant cold (45$^{o}$ to 60$^{o}$) inflow, minimum depth is 15 feet over 20 percent of the pond area, and minimum surface area is 0.5 acres.*

*For intermittent inflow, minimum depth is 20 feet over 20 percent of the pond area, and minimum surface area is 1.0 acre.*

***Warm Water Pond.*** *Minimum pond size is 1.0 surface acre. For constant inflow, minimum depth is 12 feet over 20 percent of the pond area. For intermittent inflow, minimum depth is 15 feet over 20 percent of the pond area.*

## *CRITERIA FOR RECREATION AND FIRE CONTROL*

*The 50 percent chance annual runoff from the contributing drainage area must be large enough to equal or exceed the designed permanent storage capacity.*

*Ponds with deep water (over 15 feet) located near the withdrawal location are most desirable for fire control.*

*To the extent possible, livestock should be excluded from the shorelines of recreation ponds. For water contact recreation, livestock must be excluded. Recreation ponds must have at least 50 feet wide perennial grass buffers between the pond and cropland.*

*For reaches of shoreline on recreation ponds where swimming or wading will be performed, all slopes which will be submerged below normal water line will be sloped 5:1 or flatter. This does not pertain to shoreline slopes when the slope above the designed water line is as steep or steeper than the slope below water line.*

## *CRITERIA FOR WILDLIFE WATER*

*Water developments for wildlife will refer to the wildlife habitat plan and to the species' habitat needs as identified on form SD-CPA-26.*

*The water development design will assure that the depth, duration of water presence, and shoreline slopes are adequate for the identified species' habitat needs and the identified season of use.*

*Ponds designed to provide wildlife watering facilities for large animals (antelope, deer, elk, etc.) must meet criteria for Livestock Water.*

*Exclude livestock from wildlife areas except for limited lanes for livestock water. Protect wildlife areas from vehicle travel and other intrusions.*

*A buffer of permanent vegetation at least 50 feet wide between the pond and cropland or bare areas will provide cover for wildlife using the pond.*

*Water areas planned to provide wetland conditions with wetland vegetation will be less than seven feet and have underwater shoreline slopes of 4:1 or flatter.*

## PLANS AND SPECIFICATIONS (ALL PONDS)

Plans and specifications for installing ponds shall be in keeping with this standard and shall describe the requirements for applying the practice to achieve its intended purpose.

## *OPERATION AND MAINTENANCE*

*An Operation and Maintenance Plan must be prepared for use by the landowner or operator responsible for operation and maintenance. The plan should provide specific instruction for operating and maintaining to insure proper function. Minimum requirements to be addressed in the Operation and Maintenance Plan are:*

*Prompt repair or replacement of damaged components as necessary.*

*Maintain hydraulic capacities of the channel, and control structures.*

*Periodically check the elevation of the earth fills and restore to grade, if necessary. All settlements*

*or cracks in the earth fill should be investigated to determine the cause and immediately repaired.*

*Maintain vigorous growth of vegetative coverings. This includes reseeding, fertilization, and application of herbicides when necessary. Periodic mowing may also be needed to control height.*

*Maintain installed fences to prevent authorized human access or uncontrolled grazing.*

## *REFERENCES*

*USDA-NRCS, National Engineering Field Handbook.*

*USDA-NRCS, National Engineering Handbook Series.*

*USDA-NRCS, Technical Releases.*